

METOSTRACON, A NEW SLUG-LIKE GENUS OF DART-BEARING
HELICIDE.

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PLATE III.

RECENT studies on American land-snails show that the helicine group *Belogona Euadenia*¹ is richer in genera and more widely varied in structure than could have been suspected at the time it was founded in 1895.

In the genus *Metostracon*, now to be described, we at length have a slug derived from the true '*Helix*' stock; and while the external form is remoulded to conform to the slug-like appearance, and the shell is uncoiled and completely buried, yet the soft parts unmistakably indicate its helicine antecedents.

It might be thought that a genus of slugs in the Helicidae is no novelty, for Fischer² places several slug-like genera in that family. When, however, we subtract from Fischer's heterogeneous group the genera of Aulacopod Pulmonates (*Endodontidae*, *Arionidae*, etc.), which, of course, have nothing to do with the Helices, we find not a single slug-like genus remains.

With the new genus *Metostracon*, it is proposed to associate the less modified *Xanthonyx*,³ which has been anatomically examined by Strebel and Pfeffer (*X. Cordovanus*), and by myself (*X. Salleanus*). Since there is no known genus bearing so close a relationship to *Metostracon* as *Xanthonyx*, I shall here describe the latter by way of comparison with my new genus.⁴

ANATOMY OF *METOSTRACON*.

EXTERNAL FEATURES (Pl. III, Fig. 1).—Slug, with the submedian mantle somewhat elevated, or humped, the general form like *Hemphillia*, but less elevated; sole undivided; lateral edges of foot without trace of pedal grooves or foot-margin; no distinct furrows on the median line of back or tail, and no genital groove; tail not keeled above, simply pointed behind; reticulation of the surface

¹ "Guide to the Study of Helices": Manual of Conchology, ser. II, vol. ix, p. 175.

² Manuel de Conchyl., pp. 461-473. Fischer's Helicidae include representatives of no less than seven well-characterized families, as follows: Arionidae, with the genera *Arion*, *Ariolimax*, etc.; Endodontidae, with *Patula*, *Endodonta*, etc.; Zonitidae, *Trochamorphia*, *Pseudohyalina*; Urocoptidae, *Berendtia*; Achatinidae, *Rhoda*; Bulimulidae, '*Pachyotis*'; and Helicidae, *Helix*, etc.

³ I formerly considered *Xanthonyx* to be a synonym of *Bimexia*: cf. Pilsbry & Vanatta, Proc. Acad. Nat. Sci. Philad., 1898, p. 229. This view was completely erroneous.

⁴ In explanation of certain points left in uncertainty or ignored in the following account, it should be said that I have but two specimens of *Metostracon*, one of which it was thought best to preserve uncut, and only a single example of *Xanthonyx*.

irregular, the larger polygonal meshes subdivided by a superficial network. The mantle is large, free for only a short distance in front, the lateral edges barely free, posterior margin considerably overhanging. It completely encloses the shell. The breathing pore is behind the middle of the right margin of the mantle; the genital aperture close behind the right tentacle.

SHELL (Pl. III, Figs. 5, 6) not spiral, thin, shaped like that of *Aplysia*, auct. (= *Tethys*, Linn., 10th ed., and Pilsbry); oblong-oval, somewhat convex, posterior margin obliquely truncated; apex slightly incurved, forming a very small beak-cavity; exterior glossy, covered with a thin, straw-tinted cuticle, sculptured with fine, deep, and irregular growth-wrinkles.

INTERNAL ANATOMY.—*Body-cavity* excavating the tail for a short distance (indicated by a dotted line in Pl. III, Fig. 1); the stomach and beginning of the intestine (G^2), and the main mass of the genitalia, lying in the cavity of the foot; the other folds of the intestine, the ovotestis, and the pallial organs lying in the cavity of the mantle or 'hump.'

Jaw (Pl. III, Fig. 9) arched, with eight strong ribs, the ends smooth.

Radula with teeth of helicine form, the centrals having subobsolete side cusps, and a small projection on the anterior edge of the basal plate. Laterals with the entocones suppressed. Marginals tricuspid, the entocone and mesocone united (Pl. III, Fig. 10).

Intestinal tract.—Buccal mass short and subglobular. Salivary glands separate, raggedly sagittate. Crop and stomach not separated, forming a long, wide passage which lies ventrally in the body-cavity; second fold of the gut passing forward and upward, penetrating the liver; third fold lying imbedded in the ventral face of the liver; fourth fold transverse to the body, becoming free from the liver near its termination.

'*Liver*' (Pl. III, Fig. 4, *L.*) short and compact, crowded into the dorsal cavity against the kidney.

Genitalia.—Atrium extremely short. Penis long, longitudinally many ridged inside, with an encircling swelling at its termination, where there is a fleshy partition or valve (scarcely a papilla) within; epiphallus as wide as the penis, short, bearing the retractor muscle; flagellum rapidly tapering and shorter than the epiphallus; vas-deferens slender, free. The dart-sac is inserted on the atrium, is ovate, very large in proportion to the other organs, and bears near its distal end two large, distorted, club-shaped mucous glands. These glands show branching white veins and are thin-walled distally, and each one contains a stout, fleshy terminal papilla. The walls of the dart-sac are thick and of the usual muscular tissue, but in the single specimen dissected there was no dart in the lumen. A few muscle strands connect the apex of the dart-sac with the lower end of the uterus, exactly as in the genus *Cepolis*. In fact, the whole dart apparatus is strikingly like that of *Cepolis*.¹ The vagina is long, over

¹ Cf. Man. Conch., ser. II, vol. ix, pl. lii, figs. 12, 14, and 19.

half the length of the penis; spermatheca oval, with a long duct. The free oviduct is shorter than the vagina; the uterus and albumen gland are without peculiar features. The ovisperm duct penetrates the cavity of the mantle. The ovotestis consists of numerous short, stout caeca, situated at the posterior edge of the liver within the dorsal cavity (see Pl. III, Fig. 4, *o.t.*).

Free muscles.—The retractor of the penis is inserted upon the diaphragm (Pl. III, Fig. 8, *p.r.*). The columellar muscle is very short (Pl. III, Figs. 2, 4, *col.*), and inserted upon the columella of the shell close to the apex, or upon the mantle lining this part of the ventral surface of the shell. Before emerging from the mantle-cavity it splits into two equal branches (Pl. III, Fig. 4, viewed from below). The right branch is simple for half its length, then dividing into ocular, tentacular, and labial(?) branches. The left retractor splits far nearer the insertion, the buccal retractor branching off; and much further forward it again divides into ocular and tentacular retractors. There are no caudal or pedal retractors.

Lung rather small, with a spongy reticulation near the respiratory orifice, elsewhere appearing smooth.

Kidney placed against the liver, on the right side and partially above it. (See Pl. III, Fig. 2, *k*, kidney seen from below, the liver removed; and Fig. 3, kidney from above, the attached face shaded.) The ureter was not seen, but probably follows G¹.

Heart (Pl. III, Figs. 2, 3) surrounded on the sides and below by the kidney, but the pericardium is visible above (Fig. 3).

Distribution.—Mexico (State of Michoacan).

Compared with *Xanthonyx*, *Metotracon* shows numerous similarities, but it is decidedly more slug-like. The shell has almost entirely lost the spiral form, and is completely buried in the mantle. The genitalia, while of the same general type, differ in details, the mucous glands in *Metotracon* being sac-like and inserted directly upon the dart-sac, as in *Cepolis*, while in *Xanthonyx* the glands are oblong, with slender ducts, which are inserted at the junction of the dart-sac with the vagina, as in *Micrarionta*, a subgenus of *Epiphragmophora*. The relative positions of the liver, kidney, and heart are also very different in the two genera: in *Metotracon* the heart being between two lobes of the kidney, and above the liver, while in *Xanthonyx* the heart lies to the left of the kidney, and the liver does not extend beneath it.

These differences render it certain that *Xanthonyx* is in no sense an earlier stage in the phylogenetic history of *Metotracon*. The two genera are shown by their anatomy to have descended from belogonous helices, but in rearranging their organs in the more limited space of the diminishing mantle-cavity, each has solved the problem in its own way. It is therefore likely that the divergence between the two genera began at latest almost as soon as the reduction of the mantle-cavity and shell commenced. They may have had a common helicoid ancestor, or, if not, it is obvious that their respective helicoid progenitors were very closely allied.

METOSTRACON MIMA, n.sp. Pl. III, Figs. 1-11.

Slug (as contracted in formaldehyde) about 40 mm. long, the sole about 6 mm. wide in the middle, mantle 20 mm. long, shell 13.3 mm. long. General colour smoky-grey, paler anteriorly, sparsely blotched with black, and with an irregular black dorsal stripe; mantle grey, mottled and clouded with black; sole smoky slate coloured. (See Pl. III, Figs. 1, 6, specimen from Uruapam.)

Another specimen, the type (Pl. III, Figs. 2-5, 7-11), from Morelia, is about 30 mm. long, sole 6 mm. wide in the middle, mantle 16 mm., shell ovate, 11 mm. long. Sole smoky-brown, colouring otherwise as described above.

Shell ovate or oblong, slightly convex, straw-coloured and sharply wrinkled in harmony with growth-lines, becoming smooth and white at the rather clumsy apex, across which an adnate calcareous layer is reflexed, somewhat as in *Aplysia* (auct. non Pilsbry). Interior white and lustreless; the columella represented by a small raised ledge across the very small apical cavity.

Length 13.3, breadth 7.8, convexity 1.3 mm. (Uruapam).

„ 11, „ 7.7, „ 1.5 mm. (Morelia).

Hab.—Morelia, State of Michoacan, Mexico (type locality), and Uruapam, in the same State. Collected by Mr. S. N. Rhoads.

The two specimens differ somewhat in the shape of the shell, but I do not think this indicative of specific distinction. The larger one, from Uruapam, has the penis exerted. It has not been dissected.

ANATOMY OF XANTHONYX. Pl. III, Figs. 12-15.

EXTERNAL FEATURES.—Snail vitrinoid, with submedian mantle and spiral semi-globular shell, and long, slender tail, with a more or less pronounced terminal horn. Sole undivided. Lateral margins of foot without pedal grooves, or foot-margin. Surface irregularly reticulate. Mantle with a divided body-lobe on the right side, and very shortly reflexed at the margins over the shell (or with well-developed shell-lobes, according to Strebel and Pfeffer). Genital aperture near the right tentacle.

SHELL largely exposed, spiral, etc.

INTERNAL ANATOMY.—*Jaw* flatly ribbed.

Radula helicine.

Genitalia.—Atrium very short. Penis short, swollen, its lumen containing a large papilla at the apex; the short epiphallus somewhat narrower, continued beyond the vas-deferens in a stout flagellum. Retractor of the penis inserted on the epiphallus at its junction with the penis. The small dart-sac is inserted on the atrium, and is adnate to the vagina towards the base. Where it joins the vagina, on each side, the slender ducts of two large, oblong mucous glands are inserted. The vagina is short and wide. The spermatheca small and ovate, on an extremely long duct. The ovotestis consists of several groups of short cæca, imbedded in the liver, in the apical whorls of the shell.

Free muscles.—The retractor of the penis is long and inserted in the floor of the pulmonary cavity. The two tentacular retractors seem to be inserted independently on the columella, as in *Epiphragmophora*. Both divide about midway into ocular and tentacular branches. Strebel found no buccal retractor, but a very slender one, joining the left retractor band, seemed to be present in the specimen I examined, though it was broken, and I am not positive that I correctly joined the loose ends (Pl. III, Fig. 15).

The lung (Fig. 13) is short, with spongy reticulation, chiefly near the breathing pore, adjacent to the commencement of the pulmonary vein. Heart on the left side of the kidney, which is excavated to accommodate it. Kidney large and squarish. I did not find the ureter.

Of former accounts of the anatomy of *Xanthonyx*, it may be said that Fischer's preparation of the genitalia was mutilated, and part of the structures wrongly interpreted. The specimen was probably preserved in alcohol after old-time methods. Strebel and Pfeffer¹ have given a very good account of the genus. They figure and describe large shell-lobes to the mantle, but these are almost obsolete in my specimen. The ducts of the mucous glands are longer in their figure than in my preparation, and the dart-sac (which they do not recognize as such) is smaller. The exterior is dark-coloured, while my specimen is nearly white. These differences are probably specific, Strebel and Pfeffer having dissected *X. Cordovanus*, while my specimen seems referable to *X. Salleanus*.

The relationship between *Xanthonyx* and *Metostrakon* has already been alluded to. One of the most striking features of *Xanthonyx* is the removal of the ducts of the mucous glands from their typical position upon the dart-sac to an intermediate station between the sac and the vagina, the insertions being directly at the junction of these organs. No similar case is known in the Asiatic *Belogona Euadenia*, but in America we find the same arrangement in *Micrarionta*, and in *Lysinoë* the tendency has gone further, and the mucous glands are wholly removed from the dart-sac and inserted upon the vagina. This is a process quite parallel to what has taken place in the *Belogona Siphonadenia* of Europe.

Whether *Xanthonyx* will prove to have a relative in *Cryptostrakon* remains doubtful; but the latter genus may well be a more advanced member of the same phylum. It may therefore be well to recall our scant knowledge of the group.

CRYPTOSTRACON, W. G. Binney.

Annals of the New York Academy of Sciences, i, p. 258.

This genus is completely slug-like, with rather small mantle and, according to Binney, completely enclosed shell. The breathing orifice is slightly in advance of the middle of the right margin of the mantle;

¹ "Beitrag zur Kenntniss Mexikanischer Land- und Süsswasser-Conchylien," Heft iv, p. 26, pl. x, f. 7.

the jaw is solid and arcuate with a few stout ribs, and the dentition as in the *Helices*. There are no pedal furrows. The shell is strongly depressed, with $2\frac{1}{2}$ whorls, the apical one not differentiated by special sculpture; it is open below, the columella appearing as a mere raised lamina along the sutures. It thus resembles some of the rounded species of *Haliotis*, such as *H. ovina*, in form. It is very fragile, and covered with a yellowish cuticle. Gabb's type-specimens, which are the only ones known, have been dried, though preserved in alcohol. They show the shell externally. Perhaps the mantle was not actually closed over the shell, and is retracted. The internal anatomy is unknown; but I am somewhat disposed to think that it will be found to agree in the main with *Xanthonyx*, or possibly *Metostracon*. The extreme similarity of the shell to that of *Peltella* (Brazil) and *Gæotis* (Porto Rico), both of which are bulimuline, render a decision on the systematic position of *Cryptostracon* impossible, until at least the genitalia have been examined.

GENERAL AFFINITIES OF METOSTRACON AND XANTHONYX.

At first sight one is inclined to refer these genera to the Arionidæ, the external form recalling *Binneya* and *Hemphillia*. Closer inspection shows that the resemblance is most superficial. The present genera have no pedal grooves; the folds of the alimentary canal are wholly differently disposed; the buccal retractor is united with the left ocular band in *Metostracon*, but not so in Arionidæ. The pallial organs differ widely. The genitalia are wholly diverse, *Metostracon* and *Xanthonyx* having an epiphallus and flagellum on the penis, and a dart-sac with two well-developed mucous glands, while the penis in Arionidæ never has a flagellum, and a dart-sac and mucous glands are never developed.

The Limacidæ and Philomycidæ and the slug-like elasmognathous genera *Omalonyx* and *Neohyalimax* are so obviously different from *Metostracon* and *Xanthonyx* that no special comparison is necessary. There remains only one family of American Vasopulmonata known to have slug-like members, the Bulimulidæ. The genera *Amphibulina*, *Pellicula*, *Gæotis*, and *Peltella* are more or less slug-shaped, but the jaw and dentition in these groups are clearly bulimuline, and the genitalia, so far as known, are perfectly simple, as in *Bulimulus* and *Drymeus*.

No known group of slugs, or semi-slugs, will therefore receive *Xanthonyx* and *Metostracon*; but among the Helicidæ we find that the Belogona Enadenia, or Asiatic-American group of dart-bearers, agrees in all important characters. The Californian genus *Epiphragmophora* and the Antillean *Cepolis* are apparently the nearest allies of *Metostracon* and *Xanthonyx*. The details of the genitalia are practically identical. The free muscles are nearly the same. The external characters of the foot, the jaw and dentition, the respective positions of the gonad and liver, are all in agreement. The only features in which *Metostracon* and *Xanthonyx* differ materially from the American Belogona are those directly correlated with the degeneration of the shell. The shell is reduced, the mantle modified in form, the kidney and lung greatly shortened, and the position of the heart changed.

In the muscular system, the foot retractors are absent from the ocular bands, and there is no tail retractor.

While these numerous differences are all consequent upon the reduction of the shell, and would inevitably follow such reduction, one is somewhat inclined to group the genera *Xanthonyx*, *Cryptostrakon*, and *Metostrakon* together as a subfamily. This course would, however, be premature, as it is by no means certain that the three genera originated from one and the same genus of normal Helicoid Belogona; the different way in which the displaced liver, kidney, heart, and ovotestis have been rearranged in their more confined space in the several forms suggesting parallelism rather than a common phylogeny.

EXPLANATION OF PLATE III.

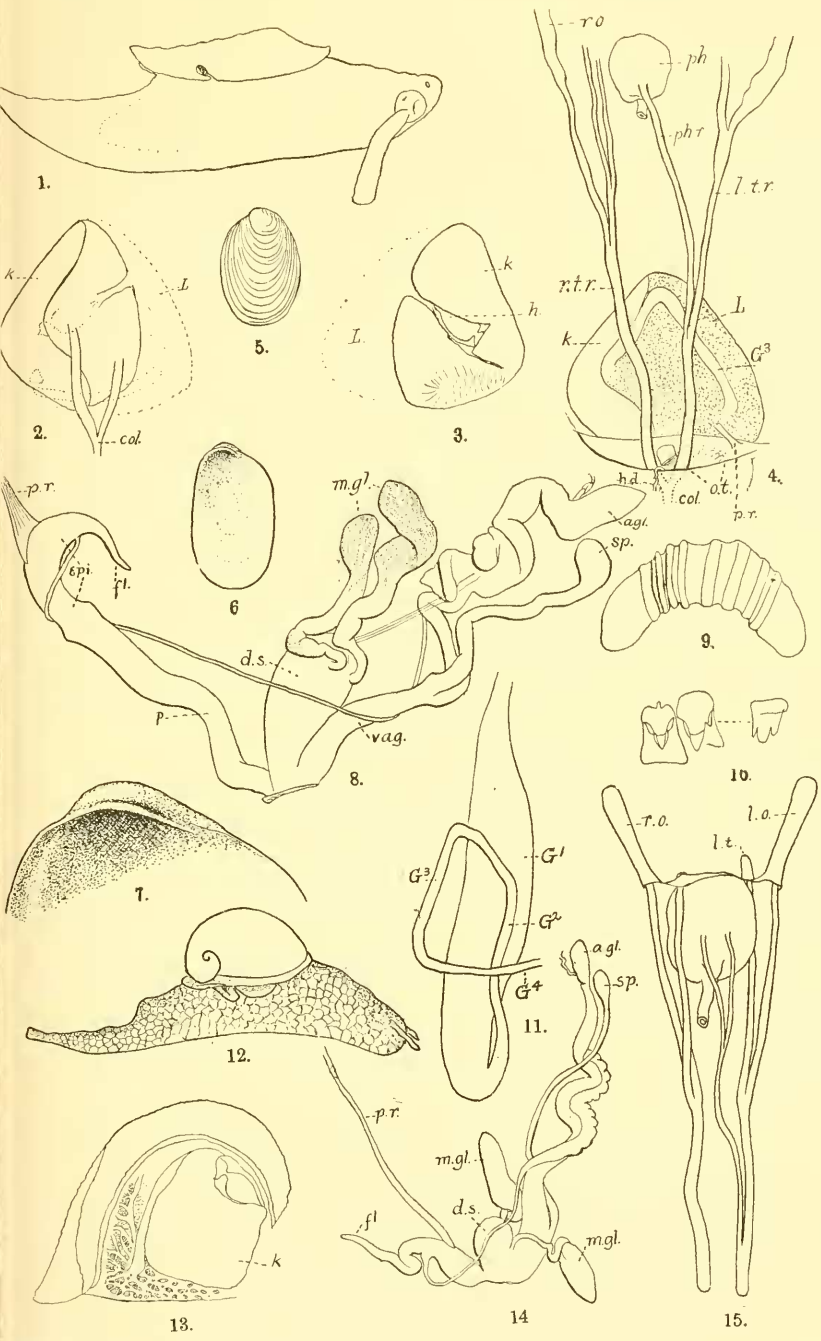
METOSTRACON MIMA.

- FIG. 1. Outline of exterior, right side, specimen from Uruapam. The penis is exerted.
 ,, 2. Kidney, from below, the liver removed, its outline and that of the concealed heart represented by dotted lines. Cf. Fig. 4.
 ,, 3. Kidney, from above, its attachment to roof of lung shaded; heart visible in the sinus between anterior and posterior lobes.
 ,, 4. Organs of visceral dome and free retractor muscles, from below.
 ,, 5. Shell of type-specimen, from Morelia, Mexico; upper surface.
 ,, 6. Shell of specimen from Uruapam; ventral surface.
 ,, 7. Apical end of same, much enlarged, showing columnellar ledge across the spire-cavity.
 ,, 8. Genitalia of type-specimen.
 ,, 9. Jaw of type-specimen.
 ,, 10. Median, adjacent lateral, and a marginal tooth of type-specimen.
 ,, 11. Digestive tract, from above. (Diagrammatic.)

XANTHONYX SALLEANUS.

- ,, 12. Animal from right side. An alcoholic specimen (collected at Texolo, State of Vera Cruz, Mexico, by S. N. Rhoads).
 ,, 13. Pallial region.
 ,, 14. Genitalia.
 ,, 15. Free retractor muscles. The restoration of the pharyngeal retractor is hypothetical, and the complete separation of the posterior ends of the tentacular retractors is uncertain.

<i>a.gl.</i>	Albumen gland.	<i>l.t.r.</i>	Left tentacular retractor.
<i>col.</i>	Columnellar muscle.	<i>m.gl.</i>	Mucous glands.
<i>d.s.</i>	Dart-sac.	<i>o.t.</i>	Ovotestis.
<i>epi.</i>	Epiphallus.	<i>p.</i>	Penis.
<i>fl.</i>	Flagellum.	<i>p.r.</i>	Retractor of the penis.
<i>G¹, G², G³, G⁴</i>	Successive folds of the intestinal tract.	<i>ph.</i>	Pharynx.
<i>h.</i>	Heart.	<i>ph.r.</i>	Pharyngeal retractor.
<i>h.d.</i>	Hermaphrodite duct.	<i>r.o.</i>	Right ocular tentacle.
<i>k.</i>	Kidney.	<i>r.t.r.</i>	Right tentacular retractor.
<i>L.</i>	Liver.	<i>sp.</i>	Spermatheca.
<i>l.o.</i>	Left ocular tentacle.	<i>vag.</i>	Vagina.



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METOSTRACON AND XANTHONYX.